International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 11 (2017) pp. 2761-2765

Using Group Technology to Form Engineering Student's Teams in Project Based Teaching Style

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Abstract

Project based teaching approach is a common teaching methodology in engineering education. Instructors form groups of students to work together toward the assigned project. In this research, Group Technology in conjunction with multi-variant statistical is used to classify students into clusters based on their preferred learning styles.

Keywords : Group Technology; Index of Learning Styles; Engineering Education; Similarity Coefficient.

INTRODUCTION

People vary not just in their learning skills but also in their learning styles [1]. Honey and Mumford defined learning style as a description of the attitudes and behaviors which determines an individual's preferred way of learning [2].In engineering studies some curriculum is designed based on using some project works, which can be done individually or in groups. This way of learning, is student centered learning which leads to a deeper learning approach through learning by doing. This type of learning allows students to use skills from different subject area and apply it to real life problem. In this study; teams of students performing project based projects are joined together according their own learning styles. Group technology concept in conjunction with selected learning style method is used to group students at class level into clusters. Each cluster is responsible for working on the same assigned project.

Group technology is a methodology that identifies and exploits common similarities among the attributes of a set of objects and clusters them into cells [3]. Cellular manufacturing is an application of group technology to manufacturing. In cellular manufacturing, machines that are usually dissimilar in function are grouped into cells. Such cells should ideally be responsible for processing groups of parts known as part family (parts with similar processing requirements [3]. The idea is to process a family of components through a dedicated cell, thereby gaining the advantages of mass production without the problem of batching[4]. Yong Yin (2006) [5] presented and reviewed different similarity coefficientsused to establish manufacturing cells. A general purpose similarity coefficient used in several application to measure the similrity between two sets of observations is called Jaccard similarity coefficient[6]: the Jaccard similarity coefficient between machine x and machine y is defined as follows:

$$S_{xy} = a/(a+b+c) \quad , \quad 0 \leq S_{xy} \leq 1 \qquad (1)$$

Where:

a : the number of parts that visit both machines,

b : the number of parts that visit machine x but not y

c : the number of parts that visit machine y but not x

Several similarity coefficients have been developed to include different weights such as production volume and operational time. A similarity coefficient that incorporated production volume data, routing sequence information, and unit operation times was introduced by Gupta and Seifoddini [7]. Large numbers of similarity coefficients have been developed to be used to identify and form part-family associated with the machine cell formation, such as clustering algorithms. Hierarchical clustering methods have been used extensively to form clusters of items based on successive mergers or successive division. Agglomerative hierarchical method starts with individual items, which means that initially; there is as many groups as items. The groups have same similarities are grouped together, and these grouped then, are grouped together based on their similarities, and so on. On other hand; division hierarchical method works by dividing the initial group into two groups based on their dissimilarities, and those groups are divided into subgroups based on their dissimilarities, and so on. In this research, Agglomerative hierarchical method will be used, particularly, single linkage clustering will be used were items are joined together according to the shortest distance between them (maximum similarity)[8]. Groups are developed by joining the closest items based on their highest similarities as follows;

- Find the smallest distance/similarities in D = $\left\{ d_{ik} \right\}$

- Merge the correspong objects, U and V to get the
- cluster $\left\{ UV \right\}$
- The distance/similarities between $\left(UV \right)$ *a*nd any other cluster, Q is computed by

$$d_{(UV\ Q)} = min\left\{ d_{UQ},d_{VQ} \right\}$$

The values d_{UQ} and d_{VQ} are the distance/similarity between the clusters *U and Q and V and Q* respectively.

- The result will be graphically shown in form of tree diagram *(dendrogram)*

The tree diagram representing items at different levels of similarity is created using the developed distance (similarity matrix). McAuley in 1972 used Jaccard similarity coefficient to the cell-formation problem[9]. Jaccard similarity coefficient between two machines is equal to the ratio of the number of parts visiting both machines to the number of parts visiting either machine.

Group technology is used in this study to classify students into groups at project level according to their learning-style preferences. Heywood [10] finds that linking learning style to teaching strategy affords positive advantages for improving student knowledge of the subject matter.

Several learning styles have been used in literature for educators to apply during their dealing with their students [11-18]. Much attention has been paid to learning styles in engineering education [19]. Students are characterized by different learning styles depending upon how they analyze and perceive information. Accordingly, providing the opportunity to students to work together in based on students' learning style is an important aspect in preparing future engineers.

Several learning-style models have been used in engineering studies, such as Myers–Briggs Type Indicator (MBTI), [20]. Other models used as learning styles are those of Kolb and of Felder and Silverman, [21]. In this study, the Felder–Silverman index of learning styles (ILS) is used to identify student learning-style preferences.

FELDER AND SILVERMAN LEARNING STYLE

Felder and Silverman Index Learning Style is based on Jung's theory of psychology [22] by answering the following five questions:

- The information student's preferred to perceive: sensory (e.g., sight, sound) or intuitive (e.g., possibilities, hunches)?
- The sensory information is perceived most effectively by: visual (e.g., graphs, diagrams) or verbal (spoken word)?
- The organization of information the student's is most comfortable with: inductive (facts are given, consequences are concluded) or deductive (principles are given, consequences are found)?
- How does the student prefer to process the information: actively (through participation) or reflectively (through simulation)?
- How does the student tend to progress toward understanding: sequentially (gradually) or globally (in leaps).

TEACHING STYLE

Once the student's learning style is known, the instructors should use the appropriate teaching approach to maximize the benefit for their learners. Active learners learn well in groups. Global learners learn by establishing the subject matter (the "big picture") of the class or the goal of the lecture and relating it to their previous experiences. For a mixed group of students, a balance is required between material that emphasizes practical problem-solving methods (sensing/active) and material that emphasizes fundamental understanding (intuitive/reflective). The instructor has to use the correct teaching approach based on student learning style. According to Felder and Silverman, sensing learners can observe the world through their senses; they like facts, data and experimentations. They also like solving problems by standard approach and they do not like surprises; they are patient with details. They have problems with timed tests because they are slow in translating symbols which leads them to read the question several times before answering. Visual learners remember best when they see things such as diagrams, flow charts, films and demonstrations

DATA COLLECTION

Undergraduate students enrolled in an engineering economy class were asked to voluntarily to participate in this research. The instructor explained to students the importance of learning styles, and further emphasis was given to how the study would be reflected in designing teams whom participate in group assignments. The students were directed to an online ILS questionnaire and were asked to print their results once they had completed it.

Signed consent was obtained from all participants (including the instructors) to ensure data confidentiality and that no personal information would be disclosed (e.g., names of students). These results were given to the instructor for data analysis. Table 1 shows the preference results obtained from 25 students participants.

TABLE I. PREFERENCE RESULTS OBTAINED FROM 25 STUDENTS PARTICIPANTS.

Student #	ACT	REF	SEN	INT	VIS	VRB	SEQ	GLO
1	7	0	9	0	9	0	0	1
2	9	0	9	0	9	0	3	0
3	3	0	1	0	5	0	0	1
4	0	1	7	0	0	1	3	0
5	5	0	5	0	0	1	3	0
6	0	1	0	7	5	0	0	5
7	3	0	1	0	1	0	3	0
8	0	0	0	5	5	0	0	1
9	0	0	0	9	1	0	0	5
10	5	0	9	0	0	1	3	0
11	5	0	7	0	9	0	3	0
12	3	0	0	3	1	0	3	0
13	0	1	0	1	1	0	5	0
14	5	0	3	0	9	0	0	1
15	1	0	3	0	11	0	0	3
16	0	9	0	1	1	0	5	0
17	9	0	0	1	7	0	7	0
18	5	0	9	0	7	0	0	1
19	0	1	1	0	3	0	1	0
20	0	1	5	0	7	0	0	1
21	7	0	0	1	5	0	3	0
22	3	0	5	0	7	0	0	3
23	0	5	5	0	5	0	3	0
24	3	0	5	0	11	0	0	1
25	3	0	1	0	1	0	3	0

The results output can be interpreted according to the web site providing the survey as:

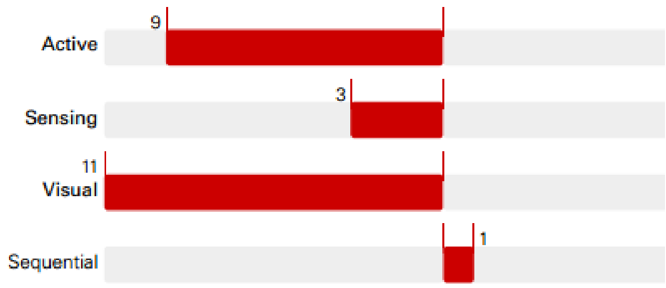

Figure 1. Learning Style Survey Output Sample

- If the students score is 1-3, he/she well balanced between the scale dimensions.
- If the student score is 5-7, he/she has moderate preference for that dimension.
- If student score is 9-11, he/she have very strong preference for one dimension and he/she may having disadvantage in an environment that fails to address that dimension

For example, the shown output in figure 1, indicate that the student surveyed will be having difficulties if he join other peers with reflective or verbal preferences. Hence, this study aiming at grouping student's teams working in the same project assignments based on their learning preferences.

Step	Number Of Cluster	Similarity Level, %	Distance Level	Clusters Joined		New Cluster	Number Of Students
1	24	100	0	7	25	7	2
2	23	84.7	2.8	1	18	1	2
3	22	82.9	3.2	7	12	7	3
4	21	81.2	3.5	15	24	15	2
5	20	81.2	3.5	14	15	14	3
6	19	79.7	3.7	20	22	20	2
7	18	79.7	3.7	1	2	1	3
8	17	78.3	4.0	14	20	14	5
9	16	78.3	4.0	3	19	3	2
10	15	78.3	4.0	7	13	7	4
11	14	78.3	4.0	5	10	5	2
12	13	77.0	4.2	1	11	1	4
13	12	77.0	4.2	3	7	3	6
14	11	75.1	4.6	6	9	6	2
15	10	75.1	4.6	6	8	6	3
16	9	74.6	4.7	1	14	1	9
17	8	74.6	4.7	3	5	3	8
18	7	73.5	4.9	17	21	17	2
19	6	73.5	4.9	1	3	1	17
20	5	71.3	5.3	1	17	1	19
21	4	70.3	5.5	1	23	1	20
22	3	70.3	5.5	1	4	1	21
23	2	68.9	5.7	1	6	1	24
24	1	57.4	7.9	1	16	1	25

DATA ANALYSIS

Single linkage clustering discussed earlier is used to develop clusters of students based on their learning styles. Minitab software package was used to achieve that, Table 2 shows the results which is translated into Figure 1.

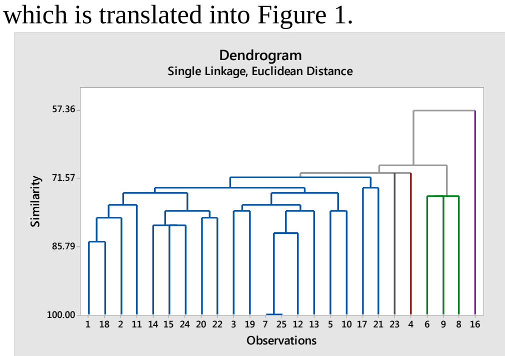

Figure 2. Dendrogram

As seen from Table II ; at step 1, student 7 join student 25 at 100% similarity of their learning style, at step 2, students 1 joins student 18 at 84.683% similarity. Table 3, illustrate the similarities between these observations (students), and so on.
Initially, the following develop clusters of students under study based on their learning styles using complete linkage clustering. The results are shown in Table II.

TABLE III. GROUPS OF STUDENTS BASED ON THEIR LEARNING STYLES

Student #	ACT	REF	SEN	INT	VIS	VRB	SEQ	GLO
2	9	0	9	0	9	0	3	0
1	7	0	9	0	9	0	0	1
18	5	0	9	0	7	0	0	1
11	5	0	7	0	9	0	3	0

Group a

Student #	ACT	REF	SEN	INT	VIS	VRB	SEQ	GLO
14	5	0	3	0	9	0	0	1
15	1	0	3	0	11	0	0	3
24	3	0	5	0	11	0	0	1
20	0	1	5	0	7	0	0	1
22	3	0	5	0	7	0	0	3

Group b

Student #	ACT	REF	SEN	INT	VIS	VRB	SEQ	GLO
3	3	0	1	0	5	0	0	1
19	0	1	1	0	3	0	1	0
7	3	0	1	0	1	0	3	0
25	3	0	1	0	1	0	3	0
12	3	0	0	3	1	0	3	0
13	0	1	0	1	1	0	5	0
5	5	0	5	0	0	1	3	0
10	5	0	9	0	0	1	3	0

Group c

Student #	ACT	REF	SEN	INT	VIS	VRB	SEQ	GLO
17	9	0	0	1	7	0	7	0
21	7	0	0	1	5	0	3	0

Group d

Student #	ACT	REF	SEN	INT	VIS	VRB	SEQ	GLO
23	0	5	5	0	5	0	3	0
4	0	1	7	0	0	1	3	0

Group e

Student #	ACT	REF	SEN	INT	VIS	VRB	SEQ	GLO
6	0	1	0	7	5	0	0	5
8	0	0	0	5	5	0	0	1
9	0	0	0	9	1	0	0	5

Group f

Student #	ACT	REF	SEN	INT	VIS	VRB	SEQ	GLO
16	0	9	0	1	1	0	5	0

Group g

RESULTS AND CONCLUSION

Using group technology presented in this research will give the instructor a good idea about their student learning preferences as groups not as individual. When the instructor plan a team work assignments, he/she should consider grouping students not based on group size, rather they should be joined together based on their learning style.
According to Felder and Silverman, if a student has strong preference toward certain learning style, he/she will feel isolated if they join group of learners belong to other learning style dimension. This study developed clusters of learners based on common learning style and dimension. For example referring to Table III group a; students 2, 1, 18, and 11 have strong and common learning styles (VIS, SEN, ACT). And they are balanced in SEQ and GLO styles. Group b; shares strong visual style dimension with moderate sensing and balanced active and global style. It can be seen that group c consists of the largest student number, i.e: 3, 19, 7, 25, 12,13,5, 1nd 10. Students belong to this group has balanced and common learning style. Other conclusion can be inferred from this approach is to check for outlier students and deal with them accordingly, for example, student 16 has his own learning preference and does not belong to any group. Finally, it is worth mentioning that each class of students should have their own clusters of learning styles. This depends upon the learning styles configurations of the total group. The instructors have develop clusters sizes based on learning styles rather than the traditional way which depends upon an equal number of students in each group.

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